506.1
E43j

DEC 29 1925

Coker.

VOL. XXXII JULY, 1916 No. 2

JOURNAL

OF THE

Elisha Mitchell Scientific Society

CONTENTS

FIFTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE 41

THE CRITICAL DYESTUFF SITUATION. *A. S. Wheeler* 53

THE SHRUBS AND VINES OF CHAPEL HILL. *W. C. Coker and H. R. Totten* 66

ISSUED QUARTERLY

CHAPEL HILL, N. C., U. S. A.

ENTERED AT THE POSTOFFICE AS SECOND-CLASS MATTER

The Elisha Mitchell Scientific Society

JAMES B. BULLITT, President.

T. F. HICKERSON, Vice-President.

JOHN E. SMITH, Secretary and Treasurer.

F. P. VENABLE, Permanent Secretary.

EDITORS OF THE JOURNAL:

W. C. COKER.

COLLIER COBB.

M. H. STACY.

Journal of the Elisha Mitchell Scientific Society—Quarterly. Price $2.00 per year; single numbers, 50 cents. Most numbers of former volumes can be supplied. Direct all correspondence to the Editors, at University of North Carolina, Chapel Hill, N. C.

Society
of
12-28-1926

JOURNAL
OF THE
Elisha Mitchell Scientific Society

Volume XXXII JULY, 1916 Number 2

PROCEEDINGS OF THE FIFTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT THE STATE AGRICULTURAL AND MECHANICAL COLLEGE, WEST RALEIGH, N. C., FRIDAY AND SATURDAY, APRIL 28 and 29, 1916

The Executive Committee—President A. S. Wheeler, Vice-president W. A. Withers, and Secretary-treasurer E. W. Gudger, *ex officio;* Z. P. Metcalf and W. C. Coker—met at 2:45 p. m. on Friday. The Secretary-treasurer reported the finances of the Academy to be in better condition than last year; and that the membership January 1, 1914, was 69, that 6 members were lost by nonpayment of dues and 1 by removal from the state, while 10 applicants were admitted; the membership on January 1, 1915, being 72.

An invitation to meet at the University of North Carolina, Chapel Hill, in 1917 was unanimously accepted. The following applicants for membership were then unanimously elected:

1. Andrews, Rev. Theodore, Lexington.
2. Balderston, Mark, Professor of Physics, Guilford College.
3. Beardslee, H. C., Professor in Asheville School for Boys, Asheville.
4. Bell, J. M., Professor of Physical Chemistry, University of North Carolina, Chapel Hill.
5. Brewer, Charles E., President Meredith College, Raleigh.
6. Browne, W. H., Jr., Professor Electrical Engineering, A. and M. College, West Raleigh.
7. Bruner, E. Murray, United States Forest Examiner, Lenoir.
8. Detjen, L. R., Assistant Horticulturist, Experiment Station, West Raleigh.
9. Gray, Dan T., Chief Division Animal Industry, Experiment Station, West Raleigh.
10. Henderson, Archibald, Professor of Mathematics, University North Carolina, Chapel Hill.

11. Johnson, E. D., Head Department Science, City High School, Asheville.
12. Kaupp, B. F., Professor of Poultry Science, A. and M. College, West Raleigh.
13. Lake, J. L., Professor Physics, Wake Forest College, Wake Forest.
14. Nowell, J. W., Professor of Chemistry, Wake Forest College, Wake Forest.
15 Pillsbury, J. P., Professor of Horticulture, A. and M. College, West Raleigh.
16. Randolph, Mrs. E. O., Elon College.
17. Randolph, Edgar E., Analytical Chemist, Elon College.
18. Rhoades, Verne, United States Forest Examiner, Asheville.
19. Riddick, W. C., Professor Civil Engineering, A. and M. College, West Raleigh.
20. Roberts, G. A., Professor of Veterinary Medicine, A. and M. College, West Raleigh.
21. Ware, J. O., Instructor in Entomology, A. and M. College, West Raleigh.
22. Wilson, Miss Margaret, Head Department of Science, High School, Wilson.
23. Wolf, F. A., Professor of Plant Pathology, A. and M. College, West Raleigh.

President Wheeler called the Academy to order in regular session at 3:15 and appointed the following committees: Resolutions, W. C. Coker, J. J. Wolfe, and George W. Lay; Auditing, Bert Cunningham, J. E. Smith, and J. S. Downing; Nominating, C. W. Edwards, Collier Cobb, and Franklin Sherman, Jr. The reading of papers was then begun with 24 members and a number of visitors present. Adjournment was had at 5:15, when seven papers had been read, that the members might take an automobile ride over the city as the guests of the local members.

At 8:15 p. m. the Academy convened in evening session in the Y. M. C. A. auditorium, where it was cordially welcomed to the A. & M. College by President D. H. Hill. Then President A. S. Wheeler of the Academy gave his presidential address on "The Critical Dyestuff Situation" with a demonstration of materials. Next Professor E. W. Gudger read his paper on "Echeneis or Remora; a Living Fish-Hook," illustrated with specimens and photographs of old figures.

The Academy met in annual business session at 9:10 Saturday morning with some 25 members present. The minutes of last meeting were read and approved. The place of next meeting was announced and the list of new members—the largest but one in the history of the Academy—was read. The Treasurer then read his

annual report as follows, and the Auditing Committee reported it correct and all accounts in order.

REPORT OF E. W. GUDGER, TREASURER, 1915-1916

RECEIPTS

Balance last audit	$ 160.97
Dues since last audit	97.00
Interest S. B. account	4.22
Total receipts	$ 262.19
Less expenses	95.41
Balance	$ 166.78

EXPENSES

Proceedings 1915	$ 75.00
Secretary's expenses 1915 meeting	5.90
Secretary's dues, 1914-1915	2.00
Printing	4.00
Postage	7.51
Clerical help	1.00
Total expenses	$ 95.41

RESOURCES

Savings bank balance	$ 108.29
Checking bank balance	58.49
Total	$ 166.78
Dues unpaid (about)	20.00
Stamped envelopes (about)	9.00
Estimated resources	$ 195.78
Estimated debts	91.25
Estimated balance	$ 104.53

OUTSTANDING DEBTS

Proceedings 1916	$ 75.00
Printing	6.25
Miscellaneous (about)	10.00
Total (about)	$ 91.25

The Nominating Committee next reported and the following officers were elected for 1916-17: President, F. P. Venable, Professor of Chemistry, University of North Carolina; Vice-president, H. C. Beardslee, Asheville School for Boys; Secretary-treasurer, E. W. Gudger, Professor of Biology, State Normal College; additional members of Executive Committee: J. E. Smith, Assistant in Geology, University of North Carolina; E. O. Randolph, Professor of Geology and Biology, Elon College; Bert Cunningham, Head of the Department of Science, Durham High School.

The Resolutions Committee then reported as follows:

1. WHEREAS, in the death of Joseph Austin Holmes the North Carolina Academy of Science has lost a most honored member—one who in his life exemplified what we believe to be the true ideals of science, in that, with complete devotion of his superb industry and rare gifts to the public good, he sacrificed ease, comfort, and even life itself that the life of his fellows might be more secure:

Therefore be it resolved, That the Secretary be instructed to extend to the family of Dr. Holmes the profound sympathy of this Academy and to incorporate a copy of this resolution in the minutes of this meeting.

2. *Resolved,* That the North Carolina Academy of Science hereby express to the officers and faculty of the A. and M. College and to the citizens of Raleigh their grateful appreciation of their abundant hospitality and of the many

kindly and thoughtful acts which have made this meeting one of the pleasantest in our recollection.

The Committee on Membership appointed in 1915 was continued for another year as follows: Chapel Hill, A. H. Patterson; Durham, Bert Cunningham; Greensboro, Miss Gertrude Mendenhall; Guilford College, Mark Balderston; Raleigh, C. S. Brimley and Z. P. Metcalf; State at large, F. Sherman, Jr., and the Secretary.

Professor J. J. Wolfe then offered the following motion, which, after some discussion, was adopted:

That the Academy take measures to secure representation in the South Eastern Association of Schools and Colleges, and that the Secretary, or, in case of his inability to attend, the President, shall represent the Academy. That the Academy pay all expenses attendant upon such representation.

It was the sense of the Academy that some scientific body be represented in the above association to offer advice as to the making out of science courses for southern high schools, and by the preceding motion the North Carolina Academy of Science offers its services.

Professor Collier Cobb called attention to the fact that no adequate mapping out of our Atlantic Coastal Plain has ever been made although very necessary from a standpoint of preparedness. On his motion the President appointed a committee to urge this matter on our congressmen. Professors Collier Cobb, E. W. Gudger, and H. C. Beardslee were named as the committee.

At 9:55 the reading of papers in the joint session of the Academy and the North Carolina Section of the American Chemical Society was begun. All the chemical papers on the Academy program and those on the Chemists' list which were of general interest were read, President Wheeler presiding. At 10:45 the two bodies separated, the reading of papers in the Academy continuing with Vice-president W. A. Withers in the chair. All papers having been finished or called for, the Academy adjourned at 1:33 p. m. Of the 23 papers on the program only 3 were read by title.

The membership of the Academy at the present time (88) is as follows, those present at this meeting being indicated by a *:

Allen, Prof. W. M.; Andrews, Rev. Theodore; Balcomb, Prof. E. E.; *Balderston, Prof. Mark; *Beardslee, Prof. H. C.; *Bell, Prof. J. M.; Brewer, Pres.

Chas. E.; *Brimley, C. S.; *Brimley, H. H.; *Browne, W. H., Jr., Prof.; Bruner, E. Murray; Bruner, S. C.; Cane, Prof. Wm.; *Carruth, F. E.; *Clapp, S. C.; *Cobb, Prof. Collier; Cobb, Wm. B.; *Coker, Prof. W. C.; Collett, R. W.; *Cunningham, Prof. Bert; *Detjen, Mr. L. R.; *Downing, Prof. J. S.; *Edwards, Prof. C. W.; Farmer, Prof. C. N.; Field, R. H.; *George, W. C.; *Gray, Dr. Dan T.; Gove, Dr. Anna M.; *Gudger, Prof. E. W.; Hammel, Prof. W. C. A.; Henderson, Prof. Archibald; *Herty, Prof. C. H.; Hickerson, Prof. T. F.; Hoffmann, S W.; Holmes, J. S.; *Hutt, Dr. W. N.; Ives, Prof. J. D.; Johnson, Prof. E. D.; Kaupp, Prof. B. F.; *Kilgore, Prof. B. W.; Lake, Prof. J. L.; *Lanneau, Prof. J. F.; *Lay, Rev. George W.; *Leiby, R. W.; Lewis, Dr. R. H.; Lyon, Prof. Mary; McIver, Mrs. Chas. D.; MacNider, Prof. W. de B.; MacNider, Dr. G. M.; Mendenhall, Prof. Gertrude; *Metcalf, Prof. Z. P.; Mills, Dr. J. E.; Newman, Prof. C. L.; Nowell, Prof. J. W.; Patterson, Prof. A. H.; Pegram, Prof. W. H.; Pillsbury, Prof. J. P.; *Plummer, Mr. J. K.; Poteat, Pres. W. L.; Potwine, Miss Elizabeth B; *Pratt, Dr. J. H.; *Randolph, Prof. E. O.; Randolph, Mrs. E. Oscar; Randolph, Prof. Edgar E.; Rankin, Dr. W. S.; Rhoades, Mr. Verne; *Riddick, Prof. W. C.; *Roberts, Dr. G. A.; Robinson, Miss Mary; *Sherman, Mr. Franklin, Jr.; *Shore, Dr. C. A.; *Smith, J. E.; *Spencer, H.; Stiles, Dr. C. W.; Strong, Prof. Cora; *Totten, Mr. Henry R.; Venable, Prof. F. P.; *Ware, J. O.; *Wheeler, Prof. A. S.; *Williams, Prof. L. F.; Wilson, Prof. H. V.; *Wilson, Miss Margaret; *Winters, Prof. R. Y.; *Withers, Prof. W. A.; *Wolf, Prof. F. A.; *Wolfe, Prof. J. J.; Wilson, R. N.; Hobbs, A. W.

In addition to the presidential address, which is published herein in full, the following papers were read:

SOME KNOWN CHANGES IN THE LAND VERTEBRATE FAUNA OF NORTH CAROLINA

BY C. S. BRIMLEY

This paper will appear in full in the next number of this JOURNAL.

THE TWO RALEIGH AMBLYSTOMA COMPARED

BY C. S. BRIMLEY

	A. punctatum.	A. opacum.
Adults.		
Color.	Brownish black with a double row of yellow spots on back and tail.	Bluish black, with a broken white stripe down each side of back connected with its fellow by white cross bars, not exceeding six in number. White cross-bars on tail.
Size.	Length about 6 to 7 inches, tail about half total length.	Length about 4 inches, tail less than half total length.

Eggs.	Laid in gelatinous masses in water in February.	Not in gelatinous masses, but separate from each other, laid in groups under dead logs in the beds of dried-up pools in October. Adults usually found curled up on eggs.
Larvae.	Develop into adults about July, attaining a length of about 2 inches.	Develop into adults about May, attaining a length of at least 2½ inches.

ARISTOTLE'S ECHENEIS NOT A SUCKING-FISH

BY E. W. GUDGER

The identity of this fish was discussed and date presented to show that it was a goby, while evidence was adduced that the "dolphin's louse," elsewhere referred to by Aristotle in his *History of Animals*, was a sucking-fish. The full paper is nearly ready for publication.

THE ECHENEIS OR REMORA; A LIVING FISH-HOOK

BY E. W. GUDGER

The tendency of this fish to adhere to turtles, sharks, or any large fish by means of its cephalic sucking disk, is made use of in many parts of the world to render easy the catching of fish. A thin cord is tied around the "small" of the tail of the fish and it is set free in the water. Finding a turtle or fish, the fisherman-fish clamps itself fast to it, and both are hauled in by the fisherman. This use of the living fish-hook was traced back to 1494, when Columbus (the first European to see it so used) witnessed its exploits on the south side of Cuba in his second voyage. The paper was illustrated by numerous photographs of illustrations in old books, showing this use of the fish. The completed paper will be published later.

SOME INTERESTING MUSHROOMS

BY W. C. COKER

Several species, new or rare in North Carolina, where shown, with photographs and paintings.

Naucoria sp. A species of this genus, not recorded from this state, has appeared in manured soil in the Arboretum of the Univer-

sity for several years. It is of good size and very resistant to decay, and was tested and found harmless, and if properly prepared so as to get rid of the bitter taste of the gills makes a very pleasant dish. As it begins to appear very early in the season, during April, and before other species of any size are out, it is a valuable addition to our list of edibles. The species seems nearest *N. hamadryas,* but differs from it in some respects.

Clavaria spiculispora Atkinson.

A painting of this species was shown. It was described from our collection of Chapel Hill plants. It is remarkable for the very deep brown color (deepest of any other American Clavaria), and the very long spicules on the spores. We have since found it in the mountains near Black Mountain. It is not known except from this state.

Amanita chlorinosma Pk.

Photographs and paintings were shown to illustrate the great range in size and color of this species. White, greenish, salmon, reddish, and ashy-brown forms occur. All the forms have a distinct odor of chlorine.

Nyctalis asterophora Fr.

A photo was shown of this plant growing on *Russula nigricans.* It is very peculiar in having another mushroom for its host, and in the degenerated gills. The functional spores are not borne on the gills as usual, but on the cap as a fine powder, and are very large and irregular.

VENEREAL INFECTIONS IN ANIMALS

BY G. A. ROBERTS

Observations, investigations and reports indicate very widespread venereal infections in this country and abroad among domestic animals, horses, cattle, sheep, swine, etc. Such infections have been known to exist in the human family for a long time.

Few people have recognized the extent and the manifold results of these infections.

The most extensive investigations and the greatest losses, direct and indirect, in animals have been among dairy cattle and breeding herds.

The specific organism responsible for the infection in cattle has all but universally been accepted as the *Bacillus abortus* (Bang) Many cases of infection with the *B. abortus* are too mild to produce clinical symptoms. The results observed in many such infections, however, are: abortions, including premature births, still births and birth of weaklings; metritis (inflammation of the uterus); and sterilities, temporary and permanent.

Retained "after-birth" is quite common in cattle when expulsion of the fetus occurs during the latter half of pregnancy, owing to the peculiar attachment between fetal membrane and the uterus at this time.

Nymphomania is not uncommon in cows and mares.

The relation of this organism to certain udder diseases and the granular venereal diseases of cattle, to some forms of calf scours and infant diarrheal troubles, has not been determined, but is suspicious of a close relationship.

Resistance and Immunity in Plants

BY F. A. WOLF

This paper contains a brief summary of the facts which have been correlated with resistance and immunity in plants in attempts to explain the underlying causes. Attention is called to several investigations dealing with morphological differences between susceptible and immune varieties. Consideration is also given to the influence of mineral nutrients in the soil upon resistance. The discussion also includes those causes which reside within the protoplasm of the host plants such as differences in acidity, tanin content, etc., of susceptible and immune varieties. It is believed that too little attention has heretofore been given to the inherent characters of the parasitic organism which determine the virulence of the parasite.

Some Methods of Making Lantern Slides

BY Z. P. METCALF

The need of some form of projection in science teaching and the general utility of lantern slides was emphasized. Two methods

of making lantern slides were discussed and examples of various kinds of lantern slides were shown.

TREES AND SHRUBS OF CHAPEL HILL

BY H. R. TOTTEN

There are seventy-four species of native trees found in the Chapel Hill neighborhood. In this number there are fourteen oaks: *Quercus alba, Q. Stellata, Q. lyrata, Q. Michauxii, Q. Prinus, Q. rubra, Q. palustris, Q. coccinea, Q. velutina, Q. falcata, Q. pagodaefolia, Q. marilandica, Q. nigra, Q. phellos.* A hybrid, probably between *Q. phellos* and *Q. falcata,* and one resembling *Q. phellos* X *Q. marilandica* are also found. This is the only known station for the Pin Oak (*Q. palustris*) in North Carolina. There are seven hickories: *Hicoria ovata, H. carolina-septentrionalis, H. microcarpa, H. glabra, H. pallida, H. alba* and *H. cordiformis.*

There are sixty-nine native shrubs. A few of the most interesting are: *Nestronia umbellula, Hydrangea arborescens, Euonymus atropurpureus, Rhododendron catawbiense, Fothergilla major, Robinia nana, Gaultheria procumbens, Gaylussacia baccata* var. *glaucocarpa* and *Symplocos tinctoria.*

ON THE SEXUALITY OF THE FILAMENT OF SPIROGYRA

BY BERT CUNNINGHAM

If zygotes occur in both filaments as the result of scalariform conjugation, the filament is said to be bisexual. This condition is called cross conjugation. All cases reported thus far have been considered as abnormalities on account of their rareness. The writer collected a species in cross conjugation in April, 1915. It has been tentatively identified as *S. inflata.* Professor G. S. West verifies this classification. This shows that bisexuality of the filament does occur in the genus. Bisexuality is due to retarded reduction. In scalariform conjugation reduction occurs in the zygote with the loss of three nuclei, while in lateral and cross conjugation, reduction takes place in the filament and no nuclei are lost. The essential difference between lateral and cross conjugation is that the cells may continue to divide after reduction in the latter, while they do not in

the former. In this respect the filament of *Spirogyra* which cross conjugates is homologous with the sporophyte of higher plants.

THE DIORITES OF THE CHAPEL HILL STOCK

BY JOHN E. SMITH

The specimens described here were obtained north of Chapel Hill where the diorities are found along Bolin's Creek. Some were taken near the inner margin of the zone and some near the creek at the foot of Clover Hill. The primary minerals as shown by the microscope are oligoclase, hornblende, quartz, magnetite, and apatite named in order of their abundance. The apatite occurs as inclusions. The oligoclase contains innumerable minute inclusions occupying most of the area of the crystals except in the narrow marginal zone which are entirely free from them. The parallel striations are in general very narrow and very close together and in some of the zones are invisible. The order of crystallization is as follows: apatite, magnetite, hornblende, oligoclase, and quartz. The secondary minerals are epidote and a small quantity of albite. They are derived from the oligoclase, magnetite, and hornblende by hydration.

The quartz decreases in amount outward from the center of the stock. The lime in the water supply of Chapel Hill is produced from this feldspar. The soils derived from the rocks of this zone constitute the Iredell series and contain little or no potash.

PHYSIOGRAPHY OF THE ISLE OF PALMS (S. C.)

BY E. OSCAR RANDOLPH

The Isle of Palms, situated eight miles to the northeast of Charleston, and connected with that city by a trolley line, has an area of approximately 4,000 acres. This sea-captured land is about six and one-fourth miles in length, and one and one-fourth miles in maximum width, tapering to a decided point at southwestern end. Physiographically, this area is interesting and instructive. In shape it approximates a ham; and by local fisherman it is called "The Ham."

From the mainland the island is separated by a narrow inlet that is wide and deep enough to convey local freight, pleasure, and fishing vessels. This back beach is subjected to no unusual geologi-

cal exigencies except tidal work. The front beach is subjected to wave, tidal, wind, and littoral current agencies. As a result, frequent shore-line configurations are effected. The writer made a number of instructive observations relative to immediate changes of epicontinental shelving between the points of high and low tide respectively.

Two well-defined sand dune ridges traverse the island lengthwise. Physiographically, incipient, migratory, temporary, and fixed dunes are in evidence. Among the flora are found sand arresters and dune fixers. The front beach is continuously attacked by wind and wave action; the interdune area is likewise undergoing change under the influence of wind-trough currents and animal life. The age and stability of the fixed dunes, ranging in height from twenty-five to forty feet, is realized in their supporting luxuriant palm trees.

ALTERATION AND PARTHENOGENESIS IN PADINA

BY JAMES J. WOLFE

At the meeting of this academy in 1913, the writer made a preliminary report on this work. It had then been carried only to the point of demonstrating that tetraspores invariably produce male and female plants. The entire series has now been completed, showing with equal certainty that fertilized eggs produce only tetrasporic plants—thus demonstrating "alteration of generations" in Padina.

In view of the fact that *Padina* grows well only in localities where it normally occurs, in the experiments dealing with parthenogenesis clean oyster shells were attached alongside those bearing unfertilized eggs to serve as controls. The results of both series were in essential respects sufficiently similar to show that all plants recovered were in both cases derived from chance reproductive bodies. Thus, it is fairly conclusively shown that unfertilized eggs, though they germinate quite freely parthenogenetically, never produce mature plants.

No abstracts have been received for the following papers:

Friday noon. George W. Lay.

Zonation in the Chapel Hill Stock. Collier Cobb.

Russulla xerampelina; a study in variation. H. C. Beardsley.

Improvements in the Method of Determining the Heating Value of a Gas (By title). C. W. Edwards.

Magnetic Separation of Minerals. Joseph Hyde Pratt.

Insect Polyembryony (Lantern). R. W. Leiby.

An Apparatus to Illustrate the Cohesion of Water—With Reference to the Ascent of Sap (By title). F. E. Carruth.

Some Recent Feeding Experiments with Cottonseed Products. W. A. Withers and F. E. Carruth.

A Study of Some Nitrifying Solutions (By title). W. A. Withers, H. L. Cox, F. A. Wolf, and E. E. Standford.

A New Industry for North Carolina (By invitation). C. P. Williams.

E. W. GUDGER, *Secretary.*

THE CRITICAL DYESTUFF SITUATION.[1]

By A. S. Wheeler.

The American people are suddenly and rapidly developing a world consciousness. While we may pride ourselves upon our remarkable development into a great and rich nation, yet the growth of cosmopolitanism has not gone on *pari passu* with the growth of our riches. We may think that our splendid educational system has given us an adequate knowledge of the world, yet it is really true that not only are we provincial as a nation, but in our home relations the different sections of our country are provincial. Our knowledge of the physical geography of the world may be fairly adequate, but the significant thing is our grasp of the character of foreign peoples. In spite of our constant contact with European peoples about whom information is so plentiful, they are not wholly understood.

The great European war, however, suddenly forced the United States into a world position. You know as well as I that we have had the habit of refraining from mixing up in European politics. We have had a fear of entangling alliances. We have been satisfied to live within ourselves. Our natural resources have been so great that we have been completely absorbed in their development and exploitation. We have paid little attention, comparatively speaking, to foreign commerce. Foreign houses through their own agents here have bought our grain and other products and have shipped them upon the high seas in their own bottoms. Having lived in a seaport I have a strong appreciation of this fact. We have practically been without a merchant marine. All the profits of transportation have gone to foreigners. Further, our development in manufacturing has not been of an all-round character such as might make us independent of others should we be thrown upon our own resources. Our tariff laws have developed certain manufactures and have throttled others. Wars involving more than two nations have been of so rare an occurence that we have been hitherto very little affected by such events. This has led us into a complacent feeling that war involving

[1]Presidential address before the North Carolina Academy of Science, Raleigh, N. C., April 28, 1916

many nations was unthinkable. We have perhaps exaggerated the growth of the brotherhood of man and have been anticipating an era of universal peace.

Suddenly and with startling rapidity all Europe plunged into war and dragged its colonies in all parts of the world into the savage contest with it. Merchant ships in large numbers were taken off the trade routes and many imports of great value to America were completely cut off. In a remarkably short time we were made to realize the intimate relations which we sustain to the rest of the world. The rich and the poor in every nook and cranny of this great land of ours had occasion to feel personally the loss of something. Either there was something that he could not get or else something for which he had to pay a higher price. This situation is growing. We were shocked only recently when we found that we had to pay 10 cents for a bottle of ink instead of 5 cents. We faced a famine in certain manufactures such as toys, scientific apparatus, lenses, organic chemicals including dyestuffs and medicines, certain textiles, etc., etc.

I am particularly concerned tonight with the dyestuff situation. Every one of us has been affected by the complete stoppage of importations of dyestuffs from Germany and by the nonexistence of an important dye manufacturing industry in our own country. We had been importing annually from Germany 22,000 tons of dyestuffs and 3,000 tons from England, France and Switzerland. Thus we were actually dependent upon Germany since England and France were also cut off, and hence could not send us the little they had been supplying us. It is true that we now get an occasional shipment from Switzerland, but this is not significant. The value of the dyestuffs which we imported from Germany annually amounted to ten million dollars. Now this is not a large sum of money as commerce goes. Woolworth, the ten-cent store man, receives about that sum in one year from candy alone. But the importance of dyestuffs rests in the industries which use them. Of these there are five important ones, textile, leather, paper, paint (including varnish) and ink. Over two million working men and women are employed in these industries and a vast number make their living by using the products of these industries. Coloring agents have become a neces-

sity to us. Our clothing, whether it be of wool, silk, or cotton, we require in a great variety of colors. This has a very practical as well as an esthetic value. If the dye could be suddenly removed from our clothes I am sure we would be shocked by its spotted condition. We call for colors in our carpets, drapery and upholstery. We demand that the leather for bookbinding, shoemaking and upholstery shall be colored red, blue, green and other colors. We call for writing paper in a variety of tints. Blotting papers, crepe and tissue papers and even wrapping papers must be colored. We color our woodwork and make cheap pine wood look like oak, cherry, rosewood or mahogany. Thus we color our floors, inside finish and furniture. For this purpose we get paints, stains and varnishes in any tint that our fancy demands. Then comes the ink industry, with 118 manufacturers producing over eleven million dollars worth of black, blue-black, red, green and violet inks. In all of these industries the actual cost of the dye is a small part of the cost of the dyed material, but its importance is none the less vital.

Being confronted with a dyestuff famine, the question arose, what can we do, what shall we do? The seriousness of the situation was recognized in the early days of the war by textile manufacturers and all others concerned. Owing to the strenuous endeavors of buyers and importers the importation through neutral countries like Holland was resumed, but continued only until March, 1915, when Germany placed an embargo upon the exportation of dyestuffs. We might still obtain dyes if Great Britain would permit us to export cotton and nitric acid to Germany. This deadlock, then, shuts us off completely from German dyes. Anticipating such a possibility, attention was early directed to a home dye industry. This, however, is an industry of great complexity. There are a number of reasons why it can not be established at once or within a short time. There is a lack of raw material, there is the necessity of constructing large plants for carrying out the great variety of processes which are required, there is the need of subsidiary related industries, there is the enlistment of large capital.

As regards capital this is a matter of the first importance. The difficulty here as always is that capital wants reasonable assurance of

success. By this I mean particularly that capital wants protection from disastrous foreign competition after the war. If capital cannot see its way clear to a permanent industry, it will not venture in. As for raw material there has been a great lack in this country. Owing to our reckless and extravagant methods we have wasted vast quantities of valuable material. Finally, the complexity of dye manufacturing may be suggested by the fact that there have been 921 different dyes on the American market, that these are made in a great variety of ways, that each particular process usually consists of many steps, and that for the many by-products there must be a market.

Before considering what Americans have already done since the outbreak of the war and what their prospects for the future are, let us sketch with extreme brevity the history of the coal tar dyes.

The coal tar dye industry originated in England in 1856. W. H. Perkin was attempting to convert an artificial base into the well-known alkaloid, quinine. Chemists are ever busy trying to make in the laboratory what nature makes so easily in plant and animal life. Perkin obtained a reddish powder instead of quinine which, you known, is quite colorless. Surprised by this result, he tried anilin, but this only gave him a black substance, but to his great astonishment alcohol dissolved out of this a most beautiful dye to which was given the name anilin purple or mauve. The name anilin purple is now obsolete. After numerous difficulties were overcome, mauve became a commercial product, the first technical coal tar dye. One-quarter of an ounce is obtainable from 100 pounds of coal. The intermediate products are shown in the table:

Coal	100 lbs.	
Coal tar	10 lbs.	12 ozs.
Coal tar naphtha	.. lbs.	8.5 ozs.
Benzol	.. lbs.	2.75 ozs.
Nitrobenzol	.. lbs.	4.25 ozs.
Anilin	.. lbs.	2.5 ozs.
Mauve	.. lbs.	0.25 ozs.

Or for one pound of mauve there are required 6,400 pounds of coal. However, a little mauve will go a very long way. Let me add one grain of this violet dye to 630,000 grains (9 gallons) of water. You see what a wonderful tinctorial power it possesses. Let me spray

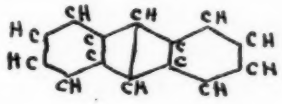
some alcohol upon this paper over which has been dusted some of the same dye. Three years after the discovery of mauve, Verguin in France produced magenta on a commercial scale. Then came Nicholson's blue in 1861, followed in 1863 by the Hofmann violets. Thus within seven years four coal tar dyes of different colors were discovered and became commercial products. From 1875 to 1885 the growth was particularly remarkable, the discoveries being made chiefly by German chemists. In this brief period we have alizarin orange, 1875; the azo dyes such as chrysoidin and naphthol orange, 1875-6; fast red, Ponceaux, Bordeaux, and Biebrich scarlet, 1878-9; phenosafranine, 1878; alizarin blue, 1878; gallein and coerulein, 1878; the eurhodines, 1879; naphthol yellow, 1879; the oxazines, 1879; neutral violet, 1880; the indophenols, 1881; the quinoline dyes, 1881; blue black and tartrazine, 1882; sun yellow, 1883; Congo red, the first direct cotton dye, 1884-5. The first indigo synthesis was made by Baeyer in 1880, but it was not a commercial success.

As you all undoubtedly know there are many dyestuffs found in plants. These are called natural dyes. They have been of great importance, but the synthetic dyes displaced them for several reasons. In the first place synthetic dyes introduced many new shades and tones which were quite unattainable with natural dyes. The synthetic dyes made possible cheaper and simpler methods of dyeing, so that the art of dyeing was no longer a mystery known only to a few, but it became an open profession. Finally, the natural dyes were driven out because they were of an inferior quality. Being extracts of plants they contain other substances which modify the color so that different lots produce varying results. Another very important objection on the score of quality is that the natural dyes do not belong to the group of fast colors. Although indigo is one of the fastest of colors, the natural indigo is made up of a mixture of indigo blue, indigo red and indigo brown. Hence variable results were obtained with the natural indigo. Logwood, once used universally for producing blacks, was fast to washing but not to light or to exposure to weather. In the old days when our black clothing was made with logwood it always faded to a rusty color. The alizarine

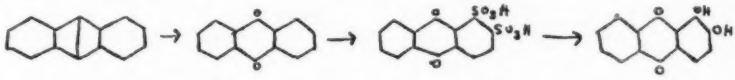
blacks which have displaced logwood are extremely fast dyes. Fustic, which gives yellows and browns, is not a fast dye. Cochineal is a red dye which held its own against the coal tar acid scarlets which first came into use, but when anthracene and chrome scarlets were introduced cochineal was abandoned. They are fugitive colors, therefore, and though in a crisis we may make some use of them, it is clear that they will never be accepted in view of their inferiority to the coal tar dyes. We can easily believe that natural dyes are not fast even if we have had no personal experience with them, when we look about us and see how the green in the grass turns brown, how the green in the leaf turns red, yellow, purple and brown, how the brilliant and varied hues of the flowers fade away to dull browns and blacks. The great superiority of the synthetic dyes has long attracted the attention of the chemist, and a fascinating field of research has been found in the endeavor to produce natural dyes in the laboratory. Two of these, alizarine and indigo, are of such great importance that I wish to run over the main points of their history.

Madder is the root of several species of Rubia, large plantations of which were cultivated in Holland, Asia Minor, Russia, and France. What we know today as alizarine was discovered and obtained from madder by Robiquet and Colin in 1831. In later times it developed as a most important dye, finding application in producing bright red shades on calico mordanted with Turkey red oil. The dye has been popularly called Turkey Red. The annual imports of madder by Great Britain in the period 1859-1868 amounted to five million dollars in value. The world's production at that time amounted to ten million dollars. The most brilliant red and the fastest which can be produced on cotton is obtained by the use of alizarine. It, therefore, very naturally attracted the attention of chemists, for there was the possibility of synthesizing an alizarine which would not only be purer and better, but also cheaper. Two German chemists, Graebe and Liebermann, attacked the problem and in 1869 succeeded in producing it from a coal tar product. If coal tar is subjected to heat, more than fifty substances distill off such as benzol, toluol, carbolic acid, naphthalene and anthracene. This last substance, anthracene, is

a crystalline compound, showing a beautiful fluorescence. It has the formula $C_{14}H_{10}$ with atoms arranged according to the following scheme:



Graebe and Liebermann heated alizarine obtained from madder, passed the vapor over hot zinc dust and obtained a product which they identified as anthracene. This discovery threw the first light upon the nature of alizarine. This occurred in 1868. The next step was to begin with anthracene and pass, if possible, to alizarine. This was accomplished within another year. The first method was not commercially successful and I will pass over it. By the second method anthracene was oxidized to anthraquinone, this was converted into a sulfonic acid with sulfuric acid which is a very cheap chemical, and finally potash converted the sulfonic acid into alizarine. This



process is remarkable for the few steps involved. Although anthracene constitutes less than one per cent of the coal tar distillation products, yet the world's production is large. England alone in 1913 exported over one-half million pounds. Synthetic alizarine rapidly drove neutral alizarine out of the market. It sold at a price one-third that of madder, and thus many millions of dollars were saved annually. Madder plantations occupied 400,000 acres of land, but now they are producing other crops. Farmers who had never known anything but madder culture were compelled to learn new agricultural pursuits.

The other dye which has attracted the popular attention of the world is indigo. Sir Henry E. Roscoe, in a lecture delivered in 1881 when there was much talk of the possible synthesis of indigo on a commercial scale, stated that the value of the world's annual crop was twenty million dollars. Indigo is obtained from a shrub, three to five feet high, which grows in India, the Philippine Islands, Java, China and Central America. During the period of the alizarine de-

velopment indigo attracted the attention of chemists, especially in Germany, and many syntheses were developed, principally by Professor Adolph von Baeyer of the University of Munich. The twenty-year quest, resulting in 1897 in complete triumph, is one of the romances of science and a striking example of the successful application of theoretical training to industrial problems. Some idea of the struggle may be seen in the fact that 152 patents were taken out in that period. The search was engaged in not only by the chemists in the big dye factories but also by chemists in the universities. Without going into many details I wish to give something of the history of this achievement. One essential in the synthesis of a commercial product is a cheap raw material. In spite of all of the other important discoveries the commercial production of indigo was not a success until it was found in the nineties that naphthalene could be used as the raw material. The first substance which gave hope was cinnamic acid, a crystalline substance occurring in Peru balsam and in storax. A laboratory method was discovered which made this a cheap article of manufacture, but subsequent operations raised the cost of producing the indigo so much that it exceeded the cost of natural indigo. In 1882 a synthesis was discovered which employed orthonitrobenzaldehyde and acetone. The method went smoothly, but serious obstacles arose in making the raw material. All possible methods were tried, but no success was attained. In 1886 another discovery raised hopes again, but these were again doomed after much investigation. Then followed a long period of quiet, but it appeared in 1896 that this field had nevertheless been assiduously worked. A new method of making orthonitrobenzaldehyde had been worked out and the process became commercially successful. But it failed again, and this time on account of the fact that an industry built up on this method could never supply the demand, owing to the limited production of toluol from which orthonitrobenzaldehyde is made. If the supply of toluol were to be increased it would mean quadrupling the supply of benzol, because these products occur in the distillation products of coal tar in the ratio of 4 to 1. However, in view of the current price of gasoline, this might find a market as a motor fuel.

In 1890 a new direction was given to the search by Heumann, who produced indigo by melting phenylglycine with potash. Difficulties again arose and success was again deferred in spite of a vast amount of experimentation. But when phenylglycine-o-carboxylic acid was found to yield indigo smoothly, it required only a few years longer of intense investigation. This substance is made from anthranilic acid and the latter from naphthalene. Since there was an annual waste of 35,000 tons of naphthalene, here was a cheap raw material in sufficient quantity for all possible demands of a synthetic indigo industry. Let us look now at the table for other interesting things in connection with this famous synthesis.

The new method on the right is that of the Badische Anilin u. Soda Fabrik, at Ludwigshafen am Rhein. This company announced in July, 1897, that this process was a complete success. Every step had to be cheapened. They developed a new method of making sulfuric acid catalytically. They improved the process of converting naphthalene into phthalic anhydride. They made chlorine by a new process, the electrolysis of salt. It was not pure, however, but they found that by liquefying it a pure product was obtained. The decline of the natural indigo industry is indicated by the fact that the German works make 95 per cent of the world's consumption.

It is very interesting to note that a new and shorter synthesis is now in operation by the Farbwerke-Hoechst Company. The table on the left shows that benzol is the starting out material. This is converted into nitrobenzol which is changed into anilin. The latter with chloracetic acid gives phenylglycine, and sodamide converts this into indoxyl. Owing to the vast increase in the production of benzol due to war conditions, this is certain to be a permanent method.

Including alizarin and indigo there are 921 different dyes in the world's markets, and these belong to 17 different chemical classes. It is a great industry and a one-nation industry practically. Now that we are cut off from the source by the war, the questions arise, can we and will we develop a dye industry of our own? We have the capital, the enterprise, the material and the chemists who know how. The total world's production amounts to one hundred million dollars, and the investment in the German plants alone amounts to four hundred million dollars. The value of production in Germany is sixty-eight million, in Great Britain six million, in Switzerland six million, in France five million and in the United States less than four million. Our own production in 1913 amounted to 3,300 tons, whereas we imported 25,700 tons. We consume therefore nearly 30,000 tons.

In considering the establishment of a dye industry in this country we must take a look at the possibility of getting a sufficient supply of raw material. When coal is burned in making gas or coke, there is a by-product of tar amounting to about 6 per cent of the coal. When this tar is distilled, we get gases, liquids like benzol, toluol and carbolic acid, solids such as naphthalene and anthracene. Enormous quantities of these materials have gone to waste in this country in part because our great steel industry, the largest in the world, has manufactured its coke in bee-hive ovens. Sixty per cent of the coke was recovered as coke but forty per cent was lost in gases and volatile oils and solids. So-called by-product coke ovens in which the by-products are collected and saved had been introduced in a limited way, but the advent of the great war and the consequent huge demand for ammunition greatly stimulated manufacturers in substituting the by-product for the bee-hive oven. This change is going

on all over the country. The transformation among the mills in the Birmingham district has been very striking and is almost complete. This, of course, means an enormously increased home production of benzol and the other essential raw materials for dye making. At present these compounds are being changed into the high explosives, picric acid and trinitrotoluol for killing men, while some, such as carbolic acid, are being reserved for the purpose of saving men. This reveals to us a matter of paramount importance. In time of war these coal tar products are turned into *explosives,* in time of peace into *dyes.* There can be no doubt that the enormous amount of material used in Germany for making dyes is now going into ammunition. This shuttlecock situation was clearly brought out recently in Congress in a hearing before the Ways and Means Committee of the House of Representatives. The Hill Bill, which proposes an increase in the tariff upon dyes, was under consideration. Manufacturers, dealers and scientists were called to give testimony as to the necessity of providing protection to this infant industry. Mr. Schoellkopf, the head of a large dye manufacturing concern in Buffalo, was asked the question, "If war were declared how soon could your dye factory begin the manufacture of ammunition?" The hearing was taking place on Friday and Mr. Schoellkopf replied, "We could begin next Tuesday." The testimony of others was to the same effect. It is clear, then, how the two operations play into each other's hands. Let us, therefore, construct dye plants now while we are at peace, for the need of them will be even more vital to us in war time.

The question of capital is another point which must be considered in establishing a new industry. Capital goes where it can see a profit. In certain limited directions the manufacture of dyes is already under way. The making of black sulfur dyes is already an industry of importance. Soon after the beginning of the war a large Buffalo concern was earnestly beseeched to greatly enlarge its production of dyes for the textile manufacturers were face to face with the necessity of closing down their mills. An agreement was entered into by which the Buffalo company was to supply certain dyes for two years at a price four times that prevailing before the war.

This high price furnished sufficient funds to enlarge the plant, so there would be no loss even if the plant were to be closed up at the expiration of the contract. This protection was essential, for it is practically certain that there are great accumulations of stocks in Germany, and our market after the war will be flooded with these stocks at ruinously low prices, and no small industry could withstand such an onslaught. Capital will not expose itself to such risks. A certain development can go on under present conditions owing to the high prices obtainable, but this is a precarious basis on which to build a great industry since prevailing conditions can not last. It will be interesting to state at this point some facts about a single German dye factory, since it gives some hint as to what is involved in starting a new industry. This plant consumes daily one thousand tons of coal, forty tons of ice, forty million gallons of water, and two and one-half million cubic feet of gas. The factory site covers five hundred acres of which one hundred acres are covered by several hundred buildings among which are forty-two miles of railway track for transporting material about the plant. Power generation and transmission require 158 boilers, 368 steam engines and 472 electric motors, while 400 telephones are in use. B. C. Hesse is authority for this statement.

The wage question has an important bearing upon the answer which shall be given to our queries. The average daily wage at the largest German dye factory, the Badische Company, was 2.71 marks, or about 65 cents in 1886, whereas it was 4.8 marks or about $1.15 in 1908. That is the daily wage increased from 100 to 177, or nearly double. As American wages are higher than European, this change is working to our advantage. We are unable to predict, however, what conditions will prevail after the war, though it seems reasonable to suppose that higher wages will be the rule.

Another consideration is that of skilled labor and the expert service of chemists. I am unable to see any serious obstacle here. The American Chemical Society, with its 8,000 members, is the largest chemical society in the world. There are many chemical laboratories in this country which can not be surpassed in Europe, not even in Germany where development has been of the highest. Our labora-

tories do not at all confine themselves to elementary instruction. The spirit of research prevails from Hell Gate to the Golden Gate, from the Canadian boundary to the Mexican border. We have chemical journals of the highest standing, and it is idle to suppose that our chemists can not insure the success of the commercial production of dyestuffs.

It is true that we have manufactured some important coal tar dyes such as magenta and naphthol yellow S and were forced to quit on account of European competition. The European plants have been organized so long that they occupy a powerful position for several reasons. In the first place their plants have long been paid for, since the average annual dividends of the twenty-one coal tar dye corporations have been 21.74 per cent. Their elaborate sales organization is thoroughly established in thirty-three other countries, and is able to meet competition with a rapidity and effectiveness that is astonishing. Their gradual development has enabled them to find a profitable use for their numerous by-products, either through sale to other chemical industries or through application to the development of a new dye in their own plants. These advantages are most powerful, and it will take a long war or else some adequate help from the American Congress to found here a permanent industry.

THE SHRUBS AND VINES OF CHAPEL HILL

By W. C. Coker and H. R. Totten

KEY TO THE SHRUBS

I. Leaves compound, alternate on the twig.
  1. Stems with prickles.
    a. Leaflets 3-5, all near the end of the leaf-stalk.
      Stems with bluish-white coating (glaucous) ..... *Raspberry* (25)
      Stems not glaucous, trailing ..... *Dewberry* (26)
      Stems not glaucous or trailing.
        Leaflets greenish on both sides ..... *High Bush Blackberry* (27)
        Leaflets white velvety below ..... *Sand Blackberry* (28)
    b. Leaflets 5-9, scattered along most of the leaf-stalk, toothed.
      Growing in wet places, tall ..... *Swamp Rose* (29)
      Growing in dry uplands, short ..... *Pasture Rose* (30)
    c. Leaflets 9-15, along most of the leaf-stalk, not toothed .... *Dwarf Locust* (31)
  2. Stems without prickles.
    Leaflets 3 ..... *Poison Oak* (34)
    Leaflets many.
      Branches downy ..... *Winged Sumach* (33)
      Branches smooth ..... *Smooth Sumach* (32).

II. Leaves compound, opposite on the twig.
  Leaflets 3, near the end of the stalk ..... *Bladder-nut* (40)
  Leaflets 5, at the end of the stalk ..... *Buckeye* (41)
  Leaflets 5-11, along most of the stalk ..... *Elder* (69)

III. Leaves compound, clustered at the ends of the slender stems; wood yellow ..... *Yellow-root* (10)

IV. Leaves simple, alternate on the twig.
  A. Edges of leaves not toothed or lobed (see also B).
    1. Leaves evergreen.
      Leaves long, narrow; stem jointed ..... *Small Cane* (1)
      Leaf blade less than 3 inches long ..... *Mountain Laurel* (49)
      Leaf blade more than 3 inches long ..... *Rhododendron* (48)
    2. Leaves not evergreen.
      Leaves broadest near the base (some may have coarse teeth) ..... *Shrubby Hackberry* (7)
      Leaves broadest near the outer end.
        Odor offensive when bruised.
          A small shrub of upland woods ..... *Upland Pawpaw* (13)
          A tall shrub or small tree of swamps ..... *Pawpaw* (12)
        Odor not offensive ..... *Dwarf Huckleberry* (55)
      Leaves broadest near the middle.
        Odor spicy when bruised ..... *Spice Bush* (14)
        Odor not spicy.
          Fruit a succulent berry.
            Leaves resinous dotted when young; branches gray; fruit blue ..... *Blue Huckleberry* (56)
            Leaves not resinous dotted; branches reddish.
              Berries blue; leaves tomentose .... *High-bush Huckleberry* (57)
              Berries black; leaves smooth or tomentose ..... *Black High-bush Huckleberry* (58)
              Berries whitish or pinkish; leaves smooth ..... *Squaw Huckleberry* (54)
          Fruit a dry pod ..... *Stagger-bush* (52)

B. Edges of leaves very obscurely or sparingly toothed or lobed.
1. Blade of leaf about as broad as long, white velvety beneath ..... *Large-leaved Storax* (64)
2. Blade of leaf about twice as long as broad.
Leaves evergreen; plants small.
Aromatic when crushed ..... *Wintergreen* (54)
Not aromatic ..... *Trailing Arbutus* (53)
Leaves not evergreen.
Leaves with hairy margins; fruit a rather long, dry pod ..... *Pink Azalea* (47)
Leaves with minute teeth; fruit a globose, dry pod ..... *Privet Andromeda* (51)
Leaves broadest near the outer end; fruit a many-seeded black berry ..... *Sparkleberry* (57)
Leaves broadest near the middle; fruit a many-seeded blue berry ..... *Low Blueberry* (60)
Leaves broadest near the base; fruit a one-seeded berry ..... *Shrubby Hackberry* (7)
3. Blade of leaf about three times as long as broad or longer.
Leaves small; fruit a black berry ..... *Black Huckleberry* (59)
Leaves over two inches long, edges undulate ..... *Prairie Willow* (2)
Leaves over two inches long, thick, sweet, often evergreen ..... *Horse Sugar* (63)

C. Edges of leaves plainly with teeth or lobes.
1. Branches thorny.
Leaves toothed but not lobed ..... *Dwarf Thorn* (22)
Leaves deeply lobed and toothed ..... *Parsley Haw* (23)
2. Branches not thorny.
Leaves with straight parallel veins from the midrib to the edge.
Edges of leaves coarsely undulate; fruit a blunt pod with two seeds ..... *Witch-hazel* (17)
Edges of leaves coarsely undulate; fruit a two-beaked pod with two seeds ..... *Fothergilla* (18)
Edges of leaves jagged toothed; fruit a nut protected by two leaf-like bracts ..... *Hazelnut* (4)
Edges of leaves jagged toothed; fruit a nut, the covering extending out as a long beak ..... *Beaked Hazelnut* (5)
Edges of leaves finely toothed, sometimes jagged; fruit cone shaped ..... *Alder* (6)
Leaves with three prominent veins from the base; root red ..... *New Jersey Tea* (42)
Leaves not as above.
Leaves long and narrow, whitish-silky beneath ..... *Silky Willow* (3)
Leaves narrow, teeth small, regular; fruit large, one-seeded ..... *Chickasaw Plum* (24)
Leaves elliptic, narrowed at both ends, teeth small and regular, velvety or smooth beneath; fruit an astringent red berry ..... *Chokeberry* (19)
Leaves ovate, tapering to a point, teeth regular, bronze when young, smooth beneath at maturity; fruit an edible red berry ..... *Shad-bush* (21)
As above, but leaves tomentose at maturity and not bronze; fruit hardly edible ..... *Swamp Shad-bush* (20)
Leaves obovate lanceolate, usually less than an inch broad; fruit small, red, less than one-quarter inch thick, with ridged seeds ..... *Deciduous Holly* (35)
Leaves more than 1¼ inches broad; fruit a red berry with ridged seeds ..... *Mountain Holly* (36)

Leaves less than 1¼ inches broad, tapering to a point; fruit a red berry with smooth seeds.....*Winterberry* (37)
Leaves ovate, tapering to a point, teeth coarse or absent; fruit a one-seeded berry .....*Shrubby Hackberry* (7)
Leaves elliptic, tapering at both ends, sweet, sometimes not toothed, sometimes evergreen.....*Horse-sugar* (62)
Leaves elliptic, tapering at both ends; fruit a dry, globose pod with a long beak.....*Swamp Leucothoe* (50)
Leaves elliptic, tapering at both ends; fruit a twin-looking cylindrical pod with a short beak.....*Virginia Willow* (16)

V. Leaves simple, opposite on the twig.
A. Edges of the leaves not toothed or lobed.
1. Leaves small, under two inches long.
Leaves with translucent dots.*
Fruit not protected by bracts.....*St. John's Wort* (45)
Fruit protected by bracts.
Leaves about one-quarter inch wide.....*St. Andrew's Cross* (43)
Leaves about one-half inch wide.....*St. Peter's Wort* (44)
Leaves without dots.
Evergreen, parasitic .....*Mistletoe* (9)
Not evergreen.
Leaves and stems tomentose.....*Indian Currant* (66)
Leaves and stems not tomentose.....*Nestronia* (8)
2. Leaves over two inches long.
Evergreen, some alternate .....*Mountain Laurel* (49)
Not evergreen.
Leaves spicy when crushed.....*Sweet Shrub* (11)
Not spicy.
Branches reddish .....*Swamp Dogwood* (46)
Branches not reddish .....*Button-bush* (65)
B. Edges of the leaves with teeth or lobes.
Leaves with three lobes.....*Maple-leaved Arrow-wood* (67)
Leaves toothed but not lobed.
Branches green; fruit warty.....*Strawberry Bush* (38)
Branches green; fruit not warty.....*Burning Bush* (39)
Branches not green.
Leaves smooth .....*Wild Hydrangea* (15)
Leaves downy .....*Downy-leaved Arrow-wood* (68)

1. *Arundinaria tecta* (Walt.) Muhl. Small Cane.

A small reed or bamboo that is abundant along large streams, as New Hope Creek, and reaching a height of 10-12 feet, often only 2.5-3 feet high when ascending banks. We have no record of its ever fruiting in this section.

2. *Salix humilis* Marsh. Prairie Willow.

A small spreading bush, usually about waist high, with narrow leaves, the edges rolled under and undulate or, on strong shoots, sometimes toothed, green above, smooth and glaucous or rusty tomentose below; growing in damp places or in damp woods as in the pines northwest of Piney Prospect. Not abundant, but often met with in low places along roads. Dates of flowering: March 21, 1915; February 23, 1916.

*Apparent when held to the light.

3. *Salix sericea* Marsh. Silky Willow.

A large spreading shrub ten or twelve feet high, common along the streams where its dark green foliage stands out in contrast to the light, delicate green of the more tree-like Black Willow; edges of leaves finely toothed and the under side covered with minute, whitish, silky hairs. Dates of flowering: March 16, 1903; March 30, 1909; March 8, 1910; April 5, 1915.

4. *Corylus americana* Walt. Hazelnut.

A shrub about six feet high, growing in or near the low grounds, as around Scott's Hole and at base of Lone Pine Hill; leaves broad, heart-shaped, and pointed, edges wavy or jagged and many toothed, hairy; fruit an edible nut covered by two leaf-like bracts. Dates of flowering: February 28, 1909; Februrary 23, 1910; March 10, 1912; February 5, 1914; February 15, 1915; January 26, 1916.

5. *Corylus rostrata* Ait. Beaked Hazelnut.

A much smaller plant than the above growing on hillsides, as on Laurel Hill and Lone Pine Hill; leaves smaller and less heart shaped than in the above; the very hairy bracts extending beyond the nut as a long beak, but very little fruit is set in this section. Dates of flowering: March 7, 1910; March 23, 1916.

6. *Alnus rugosa* (Du Roi) Spreng. Alder.

A large shrub growing along streams and damp meadows, with dark green foliage and dark bark; leaves ovate-elliptic, pointed at both ends, toothed; fruits small and cone-like, often made abnormal by the attack of a fungus (*Exobasidium alni*). Dates of flowering: February 20, 1908; January 25, 1909; February 17, 1910; March 10, 1912; February 2, 1914; February 13, 1915; January 26, 1916.

7. *Celtis georgiana* Small. Shrubby Hackberry.

A shrub of dry and mostly rocky hillsides and bluffs, as on Mount Bolus and on the rocks opposite Laurel Hill. Leaves ovate, tapering to a point, edges either entire or toothed; fruit a small tan to black, sweetish, berry that is mostly stone. Dates of flowering: April 17, 1903; April 23, 1915; April 26, 1916.

8. *Nestronia umbellula* Raf. Nestronia.

A low dioescious shrub, parasitic on the roots of trees. It is rare here, but has been found along the sandy bank of Morgan's Creek; leaves ovate, with entire edges; flowers greenish, small, borne on short pedicels at the tip of a rather long peduncle; fruit about half an inch in diameter, but is not found here as our plants are all males and bear no fruits. Date of flowering: May 1, 1909.

9. *Phoradendron flavescens* (Pursh) Nutt. Mistletoe.

This well-known plant is parasitic on most species of trees. It is common here, but is not so abundant as farther east.

10. *Xanthorrhiza apiifolia* L'Her. Yellow-root.

A low shrub with long stalked, compound leaves clustered at the ends of the slender, little-branched stems; flowers small, brownish-purple,

borne in compound racemes; wood and roots yellow. Growing mostly on margins of larger streams, as along Morgan's Creek, and at "The Caves" on New Hope Creek. Dates of flowering: March 16, 1903; March 16, 1908; March 28, 1909; March 28, 1910; April 5, 1915; March 24, 1916.

11. *Calycanthus fertilis* Walt. Sweet-shrub.

A shrub much branched at the ground, and increasing by underground runners; twigs reddish-brown, spicy; leaves ovate elliptic; flowers brownish-purple, fragrant, at the ends of short leafy shoots; fruits large and rough, something like a rose hip in shape, but larger. Rare here, but has been found in the woods back of Mr. H. H. Patterson's home, and near Carrboro.

12 *Asimina triloba* (L.) Dunal. Pawpaw.

A tall slender shrub or small tree that is common along streams and sometimes reaches a height of about 15 feet and a diameter of 2½ inches; leaves large, smooth, bad smelling; flowers dull purplish; fruits greenish or brownish, shaped like a short banana, edible. Dates of flowering: April 11, 1903; May 7, 1909; April 12, 1910; April 8, 1913; April 16, 1916.

13. *Asimina parviflora* (Michx.) Dunal. Upland Pawpaw.

A low shrub growing in upland woods, as north of the cemetery, and near Battle's Branch; leaves obovate, with a small mucronate point, thin, bad smelling when bruised. Young twigs red-hairy; flowers dark brownish purple. It is much like the above only smaller in every part, and the fruits are more knotty. Date of flowering: April 8, 1903.

14. *Benzoin æstivale* (L.) Nees. Spice-bush.

A large shrub with many long, smooth, greenish shoots of a spicy taste and odor; leaves ovate to elliptic, pointed at both ends, aromatic; fruit a small red berry-like drupe with an aromatic principle which is used in medicine. Common along the branches. Dates of flowering: March 15, 1903; March 14, 1908; February 25, 1909; March 16, 1910; March 24, 1912; April 5, 1915; March 21, 1916.

15. *Hydrangea arborescens* L. Wild Hydrangea.

Not at all common here, but found in cool, damp woods as at "The Caves," on New Hope Creek, and on the south bank of Morgan's Creek, above Davis' Ford. Leaves ovate to elliptic, pointed, prominently and evenly toothed; small flowers in large, broad clusters at the ends of the branches; outer bark on older parts of the plant thin and loose.

16. *Itea virginica* L. Virginia Willow.

A slender shrub about 3-5 feet high, with oval, pointed, finely toothed leaves; flowers small, white, fragrant, grouped along the ends of the branches in spike like clusters; fruit a small twin pod with a common beak. Here and there along branches in woods, not common. Dates of of flowering: May 18, 1903; May 17, 1908; May 15, 1909; May 6, 1910; May 9, 1913; May 18, 1915; May 21, 1916.

17. *Hamamelis virginiana* L. Witch-hazel.

A large shrub growing along the branches and on cool northern bluffs,

as Laurel Hill; leaves oval to elliptic, with a wavy edge, barely toothed; flowers yellowish, with long slender petals, appearing in fall; fruit a scurfy, blunt pod containing two polished seeds, ripens in summer. Date of flowering: November 9, 1913.

18. *Fothergilla major* Lodd. Fothergilla.

Related to the Witch-hazel, but smaller; leaves much like those of the Witch-hazel; flowers white, borne in a short dense spike, the color coming from the numerous conspicuous stamens which are white and enlarged upwards; pods hairy, with two long-pointed beaks. Grows on cool bluffs, facing north, as at Laurel Hill and The Caves. Dates of flowering: May 14, 1912; May 2, 1915.

19. *Pyrus arbutifolia* (L.) L. f. Chokeberry.

A small slender thornless shrub that is not rare in wet soil, as in the low woods west of the cemetery; leaves elliptic, toothed, remarkable in the variation shown on the under side, which may be quite smooth and shining or densely woolly tomentose; flowers small, white, borne in clusters; fruit red, small, shaped like a quince, very astringent. Dates of flowering: March 27, 1903; March 28, 1908; March 15, 1909; March 30, 1910; April 21, 1915.

20. *Amelanchier Botryapium* (L. f.) DC. Swamp Shad-bush.

A slender shrub or small tree growing usually in the low grounds, and rare at Chapel Hill. Leaves obovate, with us usually slightly cordate at base, apex acute, margin with numerous, small close-set, acute teeth, lower surface densly white-tomentose until maturity or later, whitish green when young, not purplish. Flowers in nodding racemes, usually about 6-12, both peduncles and pedicles closely pubescent, calyx lobes pubescent, reflexed at base when the petals fall, broad and abruptly long pointed; petals white, oblong. Fruit purplish red, scarcely edible, often diseased by the attack of a fungus. There is much confusion as to the correct name for this tree. In Britton's trees it is called A. *intermedia* Spach.; in Gray's Manual, 7th ed., *A. canadensis*, var. *Botryapium;* and Wiegand (Bull T. B. C. *1*: 150. 1912) calls it *A. canadensis.*

21. *Amelanchier canadensis* (L.) Medic. (A. *lævis* Wiegand) Shad-bush, Service-berry.

A shrub or small tree, much like the preceding but distinguished by the leaves being purplish brown until full maturity, and by the much more scanty pubescence on the leaves and inflorescence. By maturity the leaves are nearly or quite glabrous, but in youth there are hairs on both surfaces, the difference between our two species in this respect being only a matter of degree. Calyx lobes narrower and more lanceolate than in in the above, and the fruits more abundant and of better quality. Dates of flowering: March 8, 1903; March 15, 1908; March 1, 1909; March 23, 1910; March 26, 1912; March 23, 1916. The time of flowering differs considerably in different plants. In 1916 some were in bloom March 23, others not until April 17th. This is a rather common plant of dry woods, hillsides and creek bluffs and banks, usually a shrub but reaching at times in Chapel Hill a height of 20 feet and a diameter of 6 inches. A

tree of this size stands on the south bank of Bowlin's Creek about 100 yards northwest of the cow barn on Glenn Burnie Farm. The fruit was fully ripe on this tree on May 28, 1916.

22. *Crataegus uniflora* Muench. Dwarf Thorn. Red Haw. Rabbit Apple.

A thorny plant with small obovate to elliptic, shining leaves, the broad end toothed, leaf stalks very short; twigs fuzzy when young; flowers usually single, not clustered as in most haws, sometimes 2 or 3 together; fruit yellowish or reddish with large, deeply-toothed calyx lobes, edible. Not rare in dry open woods, along roads, etc. Dates of flowering: April 28, 1903; April 23, 1908; May 2, 1909; May 8, 1916.

23. *Crataegus Marshallii* Eggl. (*C. apiifolia* Michx.) Parsley Haw.

Leaves broadly ovate or orbicular, ¾-1½ inches in diameter, jagged toothed, and with 5-7 deep narrow clefts, leaves and twigs softly tomentose when young, the upper side of the leaves usually becoming smooth and shiny green; flowers in clusters of 10-12; fruit oblong, ¼ inch long, bright red. The Parsley Haw is found rather plentifully along the borders of low grounds, in low flat woods and in upland woods, and its delicate foliage and compact sturdy habit make it our most ornamental haw in cultivation. Occasionally this is a small tree, but with us it is almost always a shrub. In full flower April 30, 1916.

24. *Prunus angustifolia* Marsh. Chickasaw Plum.

This is the common shrub that forms the plum thickets on edges of fields and in waste places throughout most of the State. According to an old Indian tradition it was brought from beyond the Mississippi. Leaves narrow, 1-2 inches long, ⅛-⅔ inch wide, teeth very fine and close; fruits reddish or yellowish, about ½ inch in diameter, sweet and edible, borne in umbels. Dates of flowering: about March 10, 1903; March 15, 1908; February 16, 1909; March 20, 1910; March 25, 1912; March 14, 1915; March 5, 1916.

25. *Rubus occidentalis* L. Raspberry.

A brier with smooth glaucous stems, found occasionally along the edges of clearings, etc.; stems recurving and rooting at the tips; fruit purple black, falling from the dome-shaped receptacle when ripe. Date of flowering: April 15, 1903.

26. *Rubus procumbens* Muhl. Dewberry.

A trailing brier of old fields, etc., and often forming extensive mats in damp open places; prickles weak, stems rooting at the tips; fruit globose with large black druplets, ripening early. Dates of flowering: April 4, 1903; April 15, 1908; April 12, 1909; April 8, 1910; April 19, 1916.

27. *Rubus Andrewsianus* Bl'd. Southern High-Bush Blackberry.

The common large blackberry of old fields, low grounds, etc.; branches deeply grooved, prickles stout, straight or bent; leaflets greenish on both sides; fruit cylindric with many black druplets. Dates of flowering: April 12, 1903; April 20, 1908; April 27, 1909; April 16, 1910.

28. *Rubus cuneifolius* Pursh. Sand Blackberry.

A low brier with many strong prickles; leaflets thick, deep green

above, white-velvety below; fruits medium sized, of good flavor, ripening later than the other species, one form ripening as late as August and 1st of September. This species is confined to dry, sandy soil as in open woods southwest of Dr. Battle's home. It is not so common as the two preceding.

29. *Rosa carolina* L. Carolina or Swamp Rose.

The tall wild rose of wet soil as at base of Lone Pine Hill; stem with a few stout, usually bent prickles; leaflets finely toothed; flowers pink. Date of flowering: June 16, 1915.

30. *Rosa humilis* Marsh. Pasture Rose.*

The wild rose of dry soil, as in Battle's Park near the University gate; stem low, with many slender straight prickles; leaflets coarsely toothed. Dates of flowering: May 25, 1909; May 14, 1910; May 2, 1915; May 25, 1916.

31. *Robinia nana.* (Ell.) Spach. Dwarf Locust.

A rare low shrub, the stem with or without prickles; peduncles and pedicels glandular bristly; leaves and stems slightly soft-hairy or smooth; leaves compound with 9-15 leaflets, flowers large, purplish pink, pea-like; fruit a flat, slightly hairy pod. Occasional on well drained banks, as along the old Raleigh road north of Piney Prospect. Dates of flowering: May 9, 1909; May 4, 1912.

32. *Rhus glabra* L. Smooth Sumach.

A smooth shrub with large compound leaves, the leaflets toothed, white beneath; fruits small, scarlet, berry-like, with an acid taste, in large clusters at the top of the plant; pith large; stems sprouting freely from the long runner-like roots. Rather common in dry open places. Date of flowering: June 18, 1915.

33. *Rhus copallina* L. Winged Sumach.

Differs from the smooth sumach in that the stems are smaller, more woody, downy and warty; the leaflets usually are not toothed, and the leaf stalks are winged between the leaflets. Rather common along ditches, in open woods, etc. Date of flowering: July 20, 1916.

34. *Rhus toxicodendron* L. Poison Oak.

A low, slender shrub, usually consisting of a single, upright stem about 1-2 feet high, with the leaves and flowers clustered at the top; leaves compound, leaflets three, more or less lobed; flowers greenish yellow, in apical clusters; fruit a small, whitish berry. Very poisonous to most people. Common in dry woods. Dates of flowering: May 3, 1903; May 3, 1909; May 2, 1910; May 7, 1916.

35. *Ilex decidua* Walt. Deciduous Holly.

A tall dioecious shrub or small tree that is common in low woods and not rare on hillsides and flat upland woods. Leaves usually small, less than an inch wide and 2.5 inches long, obovate-oblong; berries red, smaller than in the two following, less than ¼ inch thick, and on longer

*No attempt is made to classify the cultivated roses that are sometimes found escaped in open places and around old trash piles. We have not found the sweet brier (*Rosa rubiginosa*).

stalks, the nutlets with longitudinal ridges; an attractive winter berry. Dates of flowering: April 14, 1903; April 19, 1908; April 13, 1910; April 27, 1916.

36. *Ilex monticola* Gray. Mountain Holly.

A large dioecious shrub of the upland woods and open hillsides, as at top of Lone Pine Hill; not abundant; leaves ovate-lanceolate, broad, long pointed, acute or obtuse at the base, finely toothed; fruit a small, red, berry (drupe), the nutlets with longitudinal ridges. Dates of flowering: May 8, 1903; May 12, 1909; May 5, 1910; May 10, 1913; May 29, 1915; May 17, 1916.

37. *Ilex verticillata* (L.) Gray. Winter-berry.

This differs from the large-leaved Holly in that it grows in low, damp woods, as at base of Lone Pine Hill, and the nutlets are smooth; the leaves are apt to be smaller, narrower, and coarser toothed. Not plentiful. Dates of flowering: May 29, 1909; May 25, 1910; May 29, 1915; May 29, 1916.

38. *Euonymus americanus* L. Strawberry bush.

A very common shrub with green stems, narrow, opposite, finely toothed leaves on short leaf-stalks; pods red and warted; seeds surrounded by a bright red, meaty covering, hanging out of the pod when ripe. Our wild plants are now being badly attacked and many are killed by the Euonymus scale, introduced into this counrty on the Japanese Euonymus. Dates of flowering: April 21, 1903; April 23, 1908; April 25, 1909; April 15, 1910; April 28, 1913; April 12, 1915; May 12, 1916.

39. *Euonymus atropurpureus* Jacq. Burning Bush.

A larger shrub than the above with larger leaves and moderately long leaf-stalks; fruits smooth, bright red, curiously lobed, hanging on long peduncles; seeds surrounded by a bright red, meaty covering. Date of flowering: about April 21, 1903. This is one of the rarest plants in the State and has been found here only on the sandy bank of Morgan's Creek at Scott's Hole.

40. *Staphylea trifolia* L. Bladder-nut.

A large shrub with compound leaves, the three leaflets ovate, pointed and finely toothed; fruit a large bladdery pod. Not uncommon along large streams, as at Scott's Hole. Dates of flowering: April 17, 1903; April 10, 1909; April 16, 1916.

41. *Aesculus octandra* Marsh. Buckeye.

Common as a shrub, sometimes found as a small tree, as at Lone Pine Spring; leaflets five, at the tip of a long leaf-stalk; flowers yellow, most of them with rudimentary ovaries; fruits smooth, brown, containing large, dark-brown, polished seeds. We have found two plants of this with red flowers near the pumping station where the typical form is abundant. Dates of flowering: March 27, 1903; April 3, 1908; April 25, 1909; April 3, 1910; April 23, 1915; April 14, 1916.

42. *Ceanothus americanus* L. New Jersey Tea.

Plant forming a low, broad clump of small, much branched stems with

ovate, pointed, toothed, three ribbed leaves; flowers small, white or flesh-pink, clustered on stalks that project above the leaves. Very common in dry woods and on rocky hills. Dates of flowering: May 23, 1903; May 14, 1908; May 15, 1909; May 26, 1910; May 29, 1915; May 29, 1916.

43. *Ascyrum hypericoides* L. St. Andrew's Cross.

Low, partly decumbent, almost herb-like plants with small, narrow, obovate, opposite leaves and yellow flowers with a pair of small sepals and a pair of large sepals that persist and enclose the small, dry, many seeded fruit. Very common, partially evergreen. Date of flowering: About June 30, 1916.

44. *Ascyrum stans* Michx. St. Peter's Wort.

More erect, all parts of the plant larger, and leaves much broader. Not common, and has been found here only in the damp soil near Handcock's bridge on Bowlin's Creek and on Mason's farm.

45. *Hypericum nudiflorum* Michx. St. John's Wort.

General appearance like St. Peter's Wort, but there are five short sepals instead of four long ones and they do not enclose the fruit. Found in wet soil and sandy soil along the creeks as in the meadow below Lone Pine Hill and on the sandy bank of Morgan's Creek at Scott's Hole. Flowers about the end of June.

46. *Cornus amomum* Mill. Swamp Dogwood.

A large shrub with reddish-brown branches, small white flowers in broad bunches, and small bluish berries. Common along streams. Dates of flowering: May 30, 1909; May 20, 1910; May 20, 1913; May 28, 1915; May 20, 1916.

47. *Azalea nudiflora* L. Pink Azalea or Wild Honeysuckle.

A shrub of medium size, common through the woods and along branches; flowers pink, in conspicuous clusters, appearing before or with the leaves; leaves oval, hairy at least on the margin; fruits dry, hairy, persisting through the winter. Dates of flowering: March 26, 1903; April 2, 1908; April 7, 1909; April 4, 1910; April 21, 1915; April 13, 1916.

48. *Rhododendron catawbiense* Michx. Purple Rhododendron.

A large shrub found on the rocky bluffs along Morgan's and New Hope Creeks, as at Laurel Hill and The Caves; leaves broadly elliptic, thick, evergreen; flowers large, purplish pink. Dates of flowering: April 11, 1903; April 20, 1908; April 25, 1909; April 12, 1910; May 7, 1916. The Purple Rhododendron is supposed to grow only on the mountains, but is abundant here in places and we have found it as far east as Selma, in the middle coastal plain.

49. *Kalmia latifolia* L. Mountain Laurel.

A large, evergreen shrub found with the Rhododendron; with smaller, taper-pointed leaves and saucer-shaped pink or white flowers, with curious pockets for the anthers. The leaves are poisonous to men and animals and are said to have been used at times by the Indians to commit suicide. Dates of flowering: May 10, 1903; May 10, 1909; May 16, 1910; May 11, 1915; May 14, 1916.

50. *Leucothoe racemosa* (L.) Gray. Swamp Leucothoe.

Plant about three feet high. Leaves ovate, pointed, toothed; flowers small, cylindric, white, in long racemes at the ends of the branches; fruit small, globose, dry, with the style persisting as a long beak, sepals as long or longer than the fruit and also persisting. Rare but occasionally found in wet soils in low grounds, as on the Mason Place.

51. *Lyonia ligustrina* (L.) DC. Privet Andromeda.

Similar to the Swamp Leucothoe, but the leaves are only minutely toothed; flowers white, globose, styles not persisting, and sepals shorter than the globose fruit. Rather common in poorly drained soil in flat woods, as near the east gate of the campus, and near springs and branches. Dates of flowering: May 20, 1903; May 18, 1909.

52. *Lyonia mariana* (L.) D.Don. Stagger-bush.

Smaller than the last two; the leaves not at all toothed and the cylindric flowers larger and grouped in alternate umbels along leafless stems; fruit short, cylindric, and contracted toward the top. Not rare in poorly drained woods, as near the east gate of the campus. Dates of flowering: May 3, 1903; May 3, 1909; May 2, 1910; May 6, 1916.

53. *Epigaea repens* L. Trailing Arbutus.

A small trailing plant with hairy stems, hairy, oval, evergreen leaves, and small, white to pink, sweet-scented flowers. Plentiful on shady, rocky bluffs facing north, with Rhododendron and Kalmia; rarely on bluffs facing south. Strange to say, it does not occur here except near the largest streams (Morgan and New Hope Creeks), and is not found in most of our rich woods even in the most favorable situations. Dates of flowering: March 15, 1903; March 15, 1908; March 7, 1909; March 18, 1910; March 27, 1912; March 23, 1916.

54. *Gaultheria procumbens* L. Wintergreen.

An erect little plant, with short, wiry, upright, branches from a creeping stem; leaves smooth, ovate, evergreen, the edges turned under and slightly toothed; flowers small, white, cylindric; berries red. The leaves and berries have the well known spicy odor of wintergreen. Found here only at The Caves, on rocky bluffs of New Hope Creek.

55. *Galussacia dumosa* (Andre.) T. & G. Dwarf Huckleberry.

Our smallest huckleberry, the slender, upright, little-branched stem about 5-7 inches high; leaves shiny, ovate to elliptic, with an abrupt point and turned-under edges, green on both sides; flowers small, pinkish white, with a rather large persisting bract at the base of each flower stalk; fruits black, large, glandular-bristly, edible, ripening in July. Found in dry mixed woods as east and northwest of the cemetery and on Rocky Ridge Farm; not plentiful. Dates of flowering: May 3, 1909; May 10, 1914.

56. *Galussacia baccata* var. *glaucocarpa* (Robinson) Mackenzie. Blue Huckleberry.

Plant about two feet high, leaves similar to those of the above, but without the abrupt point and with resinous globules when young; the

bract smaller and not persisting; fruits blue, with a bloom, ripening in July; edible. This is a mountain plant that has been found here only on Laurel Hill.

57. *Vaccinium arboreum* Marsh. Sparkleberry.

A shrub on the uplands or a small tree on the sandy banks and rocky bluffs along the creeks; leaf small, obvate, thick, shiny, with very minute points on the turned-under edges and a small point at the end; flower small, white, short and broad, anthers included; berries small, black, dryish, ripening in the fall and hanging on through the winter; scarcely edible. Date of flowering: May 23, 1909.

58. *Vaccinium stamineum* L. Squaw Huckleberry, Wild Gooseberry.

A medium sized shrub with reddish twigs common in dry woods; leaves elliptic or ovate, thin, not shining; flowers greenish white, short and broad, stamens longer than the petals; fruits large, whitish or pink, ripening in July, bitter and usually considered inedible, but liked by some. Our plant is the form with quite smooth leaves that are usually glaucous below, that Small has described as *V. neglectum*. Dates of flowering: April 5, 1903; April 20, 1908; April 21, 1909; April 23, 1915; May 4, 1916.

59. *Vaccinium tenellum* Ait. Black Huckleberry.

A low shrub common in dry woods, with slender, greenish, pubescent branches; leaves thin, narrow, obovate, with minutely toothed edges and a small point at the end; flowers white, narrow, cylindric; berry black with a whitish overcolor (with a "bloom"); edible. Dates of flowering: March 21, 1903; April 23, 1915; April 11, 1916.

60. *Vaccinium vacillans* Kalm. Low Blueberry.

A common, small shrub, about the size of the Black Huckleberry and often growing with it, but the greenish branches are not pubescent, the leaves are broader, and the small sweet berries are blue; edible. Dates of flowering: April 1, 1903; April 2, 1908; April 22, 1915; April 12, 1916.

61. *Vaccinium corymbosum* L. High-bush Huckleberry.

A large shrub of wet soil, with reddish twigs and ovate to elliptic, pointed leaves without teeth; twigs and leaves pubescent or smooth; flowers white or pink, cylindric; berries dark-blue, with a bloom; edible. Dates of flowering: March 15, 1903; March 30, 1908; March 11, 1909; April 16, 1915; March 27, 1916.

62. *Vaccinium fuscatum* Ait. Smooth Form (*V. australe* Small.) Black High-bush Huckleberry.

This species of Huckleberry has not been reported before from North Carolina, and is given in Small's Flora as occurring from Georgia to Florida, and westward. We have found it to be plentiful at Hartsville, S. C., and near the grave of Thomas Walter on the Santee River, so that it probably extends over most of the coastal plain in that State at least. Our Chapel Hill plant is quite smooth, and is the form that Small has named *V. australe*, while the typical form of *V. fuscatum* is described as tomentose. However, both at Hartsville and on the Santee River, the species varies to almost or quite smooth leaves, and as in other respects

the forms seem identical, we think it best to include the smooth form in *V. fuscatum*. The species is nearest *V. corymbosum*, with the same height and habitat, but is easily distinguished by the much smaller flowers and the shiny-black, smaller berries that ripen earlier. We have so far found it only in wet, flat woods near the Mason Farm.

63. *Symplocos tinctoria* (L.) L'Her. Horse-Sugar.

A large, partially evergreen shrub, with light gray bark on old stems and reddish-gray twigs; leaves thick, long-ovate, pointed, with slightly toothed edges and sweet taste; flowers small, light yellow, fragrant, borne in bunches along the twigs; fruit small, dry, cylindric, containing one seed. Found here only at The Caves on New Hope Creek.

64. *Styrax grandifolia* Ait. Large-leaved Storax.

A fine large shrub with smooth and very dark bark, and broad ovate to obovate leaves with minute distant teeth, white velvety below; flowers white, fragrant; fruits hard, dry, globose. Found near branches and on hillsides, etc.; plentiful in woods south and east of Meeting of the Waters. Dates of flowering: April 25, 1903; April 25, 1909; April 19, 1910; April 26, 1913; April 27, 1916.

65. *Cephalanthus occidentalis* L. Button-bush.

A large, rather common shrub of the low grounds, with opposite, ovate, pointed leaves and triangular stipules between; flowers in globose heads, small, white and fragrant, with long protruding styles; fruits in globose heads. Date of flowering: June 24, 1916.

66. *Symphoricarpos orbiculatus* Moench. Indian Currant.

A low shrub with loose, shreddy old bark and purplish new bark beneath; flowers small, pinkish, in the axils of the opposite, ovate, pointed leaves; berries in clusters, purplish red, hanging on through the winter. Found sparingly along old roads, as west of Carrboro. Probably introduced. Date of flowering: July 7, 1916.

67. *Viburnum acerifolium* L. Maple-leaved Arrow-wood.

A rather small, slender shrub with opposite, three lobed, coarsely toothed, maple-like leaves; large clusters of small white flowers, and reddish to purplish berries. Common in cool, rich, well-drained woods, as along Battle's branch. Dates of flowering: May 2, 1903; May 3, 1909; May 6, 1915; May 7, 1916.

68. *Viburnum pubescens* (Ait.) Pursh. Downy-leaved Arrow-wood.

Larger and more robust than the above, and easily distinguished from it by the leaves, which are smaller, ovate, and without lobes; berries black at maturity. Dates of flowering: April 17, 1903; April 19, 1908; April 18, 1909; April 15, 1910; May 6, 1911; April 24, 1913; April 25, 1916.

69. *Sambucus canadensis* L. Elder.

A large shrub with little wood and large pith; leaves opposite, compound; flowers, small and white in large flat clusters; berries small, blackish, juicy, edible when cooked. Common in low grounds and not rare along fences in uplands. Dates of flowering: May 21, 1903; May 19, 1908; May 10, 1909; May 25, 1910; May 29, 1915; May 21, 1916.

KEY TO THE VINES.

I. Tendrils or aerial rootlets present.
  A. Stems with prickles.
    Leaves bluish-white (glaucous) below.....*Glaucous-leaved Greenbrier* (2)
    Leaves not bluish-white below.
      Leaves ovate, not bristly on the margin or broadened at base or white dotted .....*Greenbrier* (1)
      Leaves variable, usually some with bristles on margin, or with light dots, or suddenly broadened at the base.*Bristly Greenbrier* (3)
  B. Stems without prickles.
    1. Leaves compound.
      Leaves alternate, leaflets five.....*Virginia Creeper* (8)
      Leaves alternate, leaflets three.....*Poison Ivy* (7)
      Leaves opposite, leaflets two.....*Cross Vine* (16)
      Leaves opposite, leaflets several.....*Trumpet Creeper* (15)
    2. Leaves simple.
      a. Leaves toothed.
        Bark not shreddy; leaves smooth and shining.*Muscadine Grape* (12)
        Bark shreddy.
          Leaves densely white-velvety below; fruits large .....*Northern Fox Grape* (9)
          Leaves whitish, rusty-velvety below; fruits small, bluish .....*Summer Grape* (10)
          Leaves green and smooth below; fruits very small, black .....*Frost Grape* (11)
      b. Leaves lobed, but not toothed; fruit with a single flattened seed .....*Canada Moonseed* (6)

II. No tendrils or aerial rootlets present.
  1. Leaves compound.
    Leaflets three, not toothed; flowers borne singly.....*Leather Flower* (5)
    Leaflets three, toothed; flowers in clusters.....*Virginia Virgin's Bower* (4)
  2. Leaves simple.
    Fruit a long, slender pod; flowers small.....*Climbing Dogbane* (14)
    Fruit a short pod; flowers large, yellow.....*Yellow Jessamine* (13)
    Fruit a black berry; flowers long-tubular, white....*Japanese Honeysuckle* (18)
    Fruit a red berry; flowers long-tubular, red; upper pair of leaves fused together .....*Woodbine* (17)

1. *Smilax rotundifolia* L. Greenbrier or Catbrier.

A common and troublesome, green, woody vine of damp woods, ditch banks, etc., with rigid prickles; leaves ovate, taper pointed, without whitish blotches or basal lobes; fruit a bluish black berry that hangs on through the winter. Dates of flowering: April 8, 1903; April 19, 1909; April 17, 1910; April 26, 1915.

2. *Smilax glauca* Walt. Glaucous-leaved Greenbrier.

Easily distinguished from the other briers in that the leaves have a bluish-white coating on the under side. Common in old fields, along hedge rows, etc.

3. *Smilax Bona-nox* L. Bristly Greenbrier.

Leaves varying in shape from ovate-lanceolate to halberd shaped with two lobes at the base, often with small bristles along the edges and with whitish blotches. Common in old fields, etc. Dates of flowering: May 13, 1903; May 12, 1909.

4, *Clematis virginiana* L. Virginia Virgin's Bower.

A woody vine with opposite compound leaves of three, ovate, toothed leaflets at the end of a long leaf stalk; flowers small, white, clustered; fruits a cluster of small, dry ovaries with long feathery styles; found in damp soil along the creeks, as on the ditch near the south foot of Mt. Bolus; rather rare. Date of flowering: May 15, 1908.

5. *Clematis Viorna* L. Leather Flower.

A smaller and less woody vine than the above; leaves mostly with three leaflets, but some of the leaves may be entire or lobed, not toothed; flowers large, nodding, with thick, brownish sepals, borne singly; fruits similar to the fruits of the Virginia Virgin's Bower. Found along the creeks and in rich, cool woods. Date of flowering: July 11, 1914.

6. *Menispermum canadense* L. Canada Moonseed.

A barely woody vine with large heart shaped, entire, angled, or lobed leaves, on long leaf-stalks which are peltately attached near the edge of the blade; fruits black, bitter, in grape-like clusters; seeds peculiar, flat and moon-shaped or more like the under side of a horse's hoof; roots yellow. Found sparingly along streams. Date of flowering: May 10, 1903.

7. *Rhus radicans* L. Poison Ivy.

Very much like the shrub Poison Oak, but is a woody vine climbing by rootlets; leaves compound, of three lobed leaflets near the end of the leaf stalk; fruits small, whitish, berry-like. Poisonous to most people; common. Dates of flowering: May 8, 1903; May 4, 1909; May 2, 1910; May 11, 1915.

8. *Psedera quinquefolia* (L.) Green. Virginia Creeper.

A woody vine with compound leaves of five, toothed leaflets at the end of the leaf stalk; climbing by tendrils ending in sticking disks and often by rootlets; fruit a small blue berry, borne in clusters. Easily distinguished from the Poison Ivy by the five leaflets. Not rare along margins of fields, as on Glenn Burnie Farm.

9. *Vitis labruska* L. Northern Fox Grape.

A grape with shreddy bark and large, toothed leaves, often lobed, the under side white-velvety; fruits large, sour, but making a fine jelly. Not common with us, but has been found on the hill north of Purefoy's Mill and at the edge of the marshy meadow north of New Hope bridge on the Durham road. This is the parent of many of our best cultivated grapes. It is the first to bloom of all the grapes.

10 *Vitis æstivalis* Michx. Summer Grape.

A much commoner grape, the leaves rusty-velvety below; fruits small, bluish, ripening early and fairly good to eat. It is the parent of several of our cultivated grapes. Dates of flowering: May 21, 1903; May 18, 1908; May 18, 1909; May 3, 1910; May 21, 1915; May 20, 1916.

11. *Vitis cordifolia* Michx. Frost Grape.

A very common grape that is easily distinguished from the above two by the smooth, green under surface of the leaf; fruits very small, black,

sour and astringent, late and not good. Dates of flowering: May 17, 1909; May 3, 1910; May 14, 1915; May 14, 1916.

12. *Vitis rotundifolia* Michx. Muscadine or Bullace Grape.

Bark not shreddy, the small, rounded, toothed leaves shiny on both sides; fruits large, in small clusters, ripening early and very sweet; common in damp or rich woods. Dates of flowering: June 6, 1915; May 28, 1916. The Scuppernong is a descendant of the Muscadine and will bear very little unless pollinated by it.

13. *Gelsemium sempervirens* (L.) Ait. f. Yellow Jessamine.

A strong vine, twining over trees or running along the ground; leaves small, opposite, evergreen; flowers large, fragrant, yellow, followed by small, dry, flattened pods. Some of the flowers are transformed into galls by the eggs of a small beetle, which are laid in the ovaries; such flowers have large corollas, but do not open. Dates of flowering: March 22, 1903; March 19, 1909; March 29, 1910; April 16, 1915; April 2, 1916.

14. *Trachelospermum difforme* (Walt.) Gray. Climbing Dogbane.

A twining vine with small opposite leaves, small yellow flowers, and long slender pods, the narrow seed with a tuft of silky hairs at one end. Occasional in low grounds, as on the Mason Farm and near the Durham road bridge on New Hope Creek. Date of flowering: June 12, 1916.

15. *Tecoma radicans* (L.) Juss. Trumpet Creeper.

A strong vine with large compound leaves with several, toothed leaflets; flowers large, reddish, trumpet shaped; pods large, long, plump. Very common. Dates of flowering: June 16, 1915; June 8, 1916.

16. *Bignonia capreolata* L. Cross Vine.

A plentiful vine of low grounds, named from the cross shown in a section of the stem; leaves compound, with two leaflets, and a tendril. Flowers large, yellowish red; pods large, flat. Dates of flowering: April 4, 1903; April 21, 1908; April 22, 1909; April 10, 1910; April 24, 1916.

17. *Lonicera sempervirens* L. Woodbine.

A small twining vine with opposite leaves that are glaucous-white below, the upper pair grown together so that the stem appears to grow through the leaf; flowers tubular, red without, yellow within; berries red. Common in woods and borders. Dates of flowering: April 4, 1903; April 19, 1908; April 12, 1909; March 29, 1910; April 21, 1913; May 4, 1915; April 19, 1916.

18. *Lonicera japonica* Thunb. Japanese Honeysuckle.

The common Honeysuckle vine with opposite, evergreen leaves; flowers tubular, whitish the first day and creamy the next; berries black. Introduced from eastern Asia, but has abundantly escaped and is often quite troublesome. Dates of flowering: May 5, 1903; April 22, 1910; April 29, 1913; May 10, 1915; May 9, 1916.

CHAPEL HILL, N. C.